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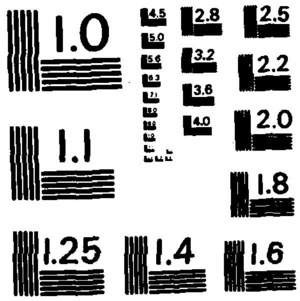

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by

E. Mankiewicz-Cudny

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By: E. Mankiewicz-Cudny

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Our Interview

IS IT SUPERCONDUCTIVITY AT 293 K?

For several years, the press has been reporting the discovery of superconductivity at room temperature at the Physics Institute of the Nicolaus Copernicus University in Torun. Professor Kazimierz Antonowicz, who carries out this work, makes the reservation already at the beginning of this interview that this is only the first step, and he does not yet put the dot over the "i". We consider, however, that the case is interesting, although difficult, and that undoubtedly it will be received with interest by readings of HT (Horyzonty Techniki).

- For a layman (nonscientist), superconductivity means disappearance of electrical resistance and the conductivity of current without thermal losses, appearing in some materials at low temperatures. Professor Antonowicz, perhaps before discussing the nature of your discovery, would you like to supplement our views on the phenomenon of superconductivity?

- This is one of the most complex problems of modern physics, and it is not possible to describe it in a few words. Studies of this problem are still going on. It is known that in crystal lattice conditions can arise when two electrons are coupled into a "pair" (the so-called Cooper pair). Electron pairs are subject to different statistics than are single electrons, and when their population in one state is sufficiently large, the phenomenon of superconductivity appears. Such a population of state takes place at very low temperature (on the order of 20 K), at critical temperatures.

- And why are the critical temperatures so low?

- This is the result of the structure of the crystal lattice and the mechanism of interaction between the electrons. The critical temperature depends, among others, on the mass of ions forming the

crystal lattice of the given material. In 1962, W. A. Little calculated that, if these ions were replaced with electrons, which are many times lighter, the phenomenon of superconductivity in such a molecule would appear at a temperature much higher than room temperature--at about 2000 K. So far, such a molecule could not be made.

This theory was strongly critized, but it has initiated a new approach to superconductivity. In the Moscow center, the group of scientists headed by V. C. Ginzburg advanced a theory that, as a result of suitable mixing of a metal with nonmetal (so that electrons in the conductivity band of metal would give the effect of superconductivity, while electrons in an insulator would be subject to polarization) one could obtain material exhibiting superconductivity at room temperature.

- Hence, your discovery of the appearance of superconductivity at room temperature is not really a surprise, since appropriate theoretical bases and studies existed already.

- I would like to say here that I was never concerned with the phenomenon of superconductivity, and that it was only by accident that I became involved in the present study. For many years, I have investigated the properties of amorphous carbon. Such a carbon, suitably prepared, has different electrical and mechanical properties than ordinary carbon and graphite. About 1970, I became interested in the so-called shunting (switching) effect. This effect consists of the fact that after applying an appropriate electric field to some dielectrics, they switch into a state of high conductivity, i.e., their resistance decreases by several orders of magnitude. A conditon for a dielectric to undergo such a jump is the amorphism of material. So far this effect was studied in glazes, but I started to study this effect in amorphous carbon. However, I was not able to explain the results obtained on the basis of old methods.

- So that is how you became interested in superconductivity, Professor Antonowicz?

- In 1962, Professor B. D. Josephson (Nobel Prize winner), published his work on superconductivity. After getting acquainted with that work, I came to the conclusion that it offers the explanation for my experiments with carbon. And it was then that I changed my specialty.

- And what is the essence of the Josephson effect?

- If we have two superconductors separated by a narrow insulating layer (of the order of 10 angstroms), then electron pairs pass through this layer from one superconductor to the other, that is, we have a flow of current. Josephson described his effect mathematically. I started experiments whose aim was to find out if my results could be described by means of the same mathematical relations.

A feature of the Josephson junction is a strong dependence of current flowing through it on the magnetic field (the magnitude of this field is of the same order as that of the Earth's magnetic field). The maximal current flowing through the junction changes sinusoidally depending on magnetic induction of the applied field. My experiments confirmed that in the investigated carbon sample, the maximal current depends also in the same way on field changes. I realized then that it could be superconductivity and I published my experimental results.

Another feature of the junction is that if a current larger than the maximal current (I_{max}) is passed through it, high frequency oscillations will appear. In the microwave field, the current increases by jumps passing through the junction, depending on potential. One obtains thus a stepwise graph of current as a function of potential. By applying an external field, I studied this relation. From the obtained results, one can calculate the ratio e/h which, as is known, is constant (e--electron charge, h--Planck constant). I calculated this ratio from the relation

$$n h \nu = 2 e U_n$$

(ν--frequency of applied field, U_n--applied potential, n--an integer).

I obtained results close to the theoretical ones. That was then the next evidence that I was observing the phenomenon of superconductivity at room temperature.

- Professor Antonowicz, when I talked to you on the telephone to arrange this interview, you said that the obtained results might not be interesting to our readers, because this discovery has no practical importance at all.

- That is true. We started our talk with an introduction to the theory of superconductivity, but perhaps we should have started by saying that I obtain the effect in very thin samples which "live" for several hours at the most. The observed superconductivity effect, just as the Josephson effect, occurs in the area of 10 angstroms, in the sample of carbon located between two layers of dusted aluminum. Hence, this is basic research. We have still many unknowns. Just now we are starting experiments to confirm whether our discovery indeed means superconductivity. We want to investigate whether this junction emits microwaves at low temperatures.

We have still many problems remaining, beginning with technological difficulties--preparation of samples and ending with theoretical doubts.

- Professor Antonowicz, I realize, of course, that the road is very long from the first experiments to practical utilization, although this road has been considerably shortened in our time. I hope that you will continue to get further positive results and that the problems can be overcome. My best wishes to you and your whole team.

Interviewed by Ewa Mankiewicz-Cudny

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